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ORIGINAL RESEARCH

Physical activity as a protective factor against depressive symptoms in older Chinese veterans in the community: result from a national cross-sectional study

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Background: Physical activity is generally considered to be effective in reducing the prevalence of depression and promoting remission of its symptoms. However, large-scale epidemiological research on this issue is lacking in older Chinese adults. We performed a nationwide epidemiological survey to determine the relationship between physical activity and depressive symptoms in older Chinese veterans in the community, with adjustment for potential confounders.

Methods: A cross-sectional study was conducted in a representative sample of 9,676 community-dwelling older Chinese veterans. Depressive symptoms were identified using the Center for Epidemiological Studies Depression Scale. Physical activity was self-reported using a one-year physical activity questionnaire. Information about covariates was obtained by questionnaire-based interview. Relationships between study variables and symptoms of depression were estimated using unadjusted and adjusted analyses.

Results: The median age was 82.29 (interquartile range 80.25–84.60) years. In total, 81.84% of the study participants engaged in physical activity that was predominantly light in intensity. In unadjusted analyses, physical activity was associated with a significantly decreased likelihood of depressive symptoms (5.43% versus 18.83%, $P<0.0001$). Multivariate logistic regression with adjustment and controlling for confounders, physical activity was still inversely associated with depressive symptoms and was the only independent protective factor (odds ratio 0.57, 95% confidence interval 0.44–0.72, $P<0.0001$) among the associated factors in this study. In a univariate general linear model, there was a significant difference in Center for Epidemiological Studies Depression Scale score between subjects participating in active physical activity and those who did not ($F=59.07$, $P<0.0001$).

Conclusion: This study found an inverse relationship between physical activity and symptoms of depression in older Chinese veterans in the community. It was also indicated that the antidepressant effect of physical activity probably extended to the oldest-old, and the light-intensity physical activity was probably available for the same protective effect. This information could be used to devise further interventions to prevent or ameliorate symptoms of depression.

Keywords: physical activity, depression, protective factor, older adults, Chinese veteran

Introduction

Depression is a common mental health problem in older adults, not only affecting mood but also leading to functional decline in those affected. It reduces quality of life and well-being, and increases the risk of disability, suicide, and mortality. Moreover, it has a significant impact on families and health care organizations.[1] The World Health Organization projects that depression could become the single highest contributor to the

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global disease burden by 2030.[2] Management of depression in older adults is critical, and strategies to prevent and reduce depressive symptoms are urgently needed. Physical activity, being a noninvasive and low-risk behavior, is an alternative or complementary intervention that can be used to prevent and treat depressive symptoms.[3,4]

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that results in energy expenditure, and can be categorized as occupational, sporting, conditioning, household, or other activity.[5] It is generally considered an effective intervention for decreasing the prevalence of depressive symptoms and promote their remission.[6–13] However, this conclusion is based mainly on results from studies in the general population[6,7] or in special populations such as adolescents,[8] postnatal women,[9] menopausal women,[10] immigrants,[11] and patients with certain conditions such as type 2 diabetes or obesity undergoing bariatric surgery,[12,13] all of whom are likely to derive a benefit. In older adults, whose ability and practice for PA is age-related decline,[14] it is controversial about whether changed patterns of PA (eg, intensity weakens, duration shortens, or frequency reduces) are still effective to maintain mental health.[4] There are some evidence in support of, as follows.

Firstly, cross-sectional studies have found an inverse correlation between PA and symptoms of depression in older adults,[15–17] and agree that engaging in more PA is associated with a lower risk of such symptoms. A nonclinical study by Salguero et al in 436 older Spanish people aged 60–98 years concluded that PA was related to both the physical and mental components of health-related quality of life and the risk of depressive symptoms (odds ratio [OR] 0.155, $P<0.01$).[15] Another nonclinical study in the USA, conducted as part of the National Social Life, Health and Aging Project in 1,349 older people aged 65–85 years, showed that PA in later life was correlated inversely with symptoms of depression ($r=-0.30$, $P<0.001$).[16] A nonclinical study in 2,727 older subjects (≥65 years) from the Taiwan National Health Interview Survey by Chen et al established that leisure time PA was associated with fewer depressive symptoms. Compared with participants expending 2,000+ kcal/week on PA during leisure time, the risk of experiencing depressive symptoms was significantly higher in those expending 1–999 kcal/week (OR 2.06, $P<0.01$) and 0 kcal/week (OR 3.72, $P<0.001$).[17]

Secondly, many longitudinal studies have confirmed that engaging in PA can reduce the incidence of depressive symptoms in older adults, as well as ameliorate these symptoms or increase the likelihood of their remission.[18–20] Lucas et al conducted a prospective, 10-year clinical and nonclinical study in 49,821 older American women aged 50–75 years, and found that higher levels of PA were associated with a lower incidence of depression, and the multivariate relative risk comparing the highest level (≥90 minutes/day) with the lowest level (<10 minutes/day) of PA was 0.80 ($P<0.001$).[18] Ku et al conducted an 11-year, nonclinical follow-up study in 1,160 older Taiwanese adults aged ≥67 years from the Taiwan's Health and Living Status of the Elderly Survey, and found that initial levels of PA were negatively associated with changes in depressive symptoms ($\beta=-0.34$, $P<0.05$).[19] However, the conclusions of longitudinal studies are not always consistent. A 2-year nonclinical follow-up study by Walker et al in 909 older Australians aged 60–74 years reported that PA did not decrease depressive symptoms at any point in time ($F=1.65$, $P=0.177$).[20]

Thirdly, interventional trials have confirmed that PA is effective in reducing depressive symptoms or enhancing the effect of antidepressant medication in older adults.[21–25] Pereira et al conducted a randomized controlled nonclinical trial in 451 older Brazilian women aged 65–89 years, and found a significant difference in pre-intervention and post-intervention Geriatric Depression Scale scores in both muscle strength exercise and aerobic exercise ($F=38.18$, $P=0.001$), indicating that the effects of both exercise protocols were comparable with regard to decreasing depressive symptoms ($F=1.76$, $P=0.185$).[21] Other research, such as a nonclinical study by Lincoln et al in older American patients with diabetes (n=58, ≥65 years, $F=20.38$, $P<0.0001$)[22] and another by Williams and Tappen in older American patients with Alzheimer's disease (n=45, 71–101 years, $F=3.26$, $P=0.0492$)[23] also demonstrated a positive effect of PA training on depressive symptoms. In addition, a nonclinical study of qigong by Tsang et al (n=82, ≥65 years, $F=2.619$, $P=0.041$)[24] in Chinese Hong Kong and a clinical study of tai chi by Lavretsky et al (n=112, ≥60 years, $F=2.26$, $P<0.05$)[25] in American patients with major depression were demonstrated to have the same effects. With advances in research on the antidepressant effects of PA, the potential for its use as a treatment for depression is being increasingly recognized. However, there were still challenging results of studies questioning the effects of PA. An important nonclinical randomized controlled trial in the UK published recently in *The Lancet* showed no statistically significant benefit of PA on depression in 891 elderly care home residents aged ≥65 years (OR 0.76, $P>0.05$), and concluded that moderately intense exercise did not reduce depressive symptoms.[26]

Lastly, there have been some positive systematic review findings and guideline recommendations made regarding PA for health purposes in the aged population.[27–31] A systematic

review by Bridle et al of the effect of exercise on depressive symptoms in older adults concluded that:

> …for older people who present with clinically meaningful symptoms of depression, prescribing structured exercise tailored to individual ability will reduce depression severity.[27]

Guidelines from the American College of Sports Medicine and the American Heart Association on PA for older adults recommend:

> …a minimum of 30 minutes on 5 days each week for moderate-intensity aerobic PA, or a minimum of 20 minutes on 3 days each week for vigorous-intensity aerobic PA.[28]

In Korea, the recommendation from the National Council of Sports for PA is "…at least 30 minutes of at least moderate activity on three or more days a week".[29] Most recommendations reached a consensus that at least moderate-intensity PA has a positive effect on general health. However, a nonclinical study by Loprinzi in 708 American older adults (aged ≥65 years) found that both light (OR 0.80, P=0.01) and moderate to vigorous (OR 0.78, P=0.01) intensity PA were inversely associated with depression, and confirmed that even light-intensity PA can have a positive effect on depressive symptoms.[30] A systematic review of PA and prevention of depression by Mammen highlighted that "there is promising evidence that any level of PA, including low levels (eg, walking up to 150 minutes/weeks), can prevent future depression", with study population samples ranging in age from 11 to 100 years.[31]

To summarize, in spite of the challenge of some studies showing a "…moderate at best" or no statistically significant effect of PA on depression in older adults,[26] PA is expected to becoming accepted as a low-risk and highly cost-effective intervention for depressive symptoms. PA could be promoted as a public health strategy to modify depressive symptoms in later life. The USA and Europe have undertaken a number of epidemiological and experimental investigations of PA and depressive symptoms in the elderly.[15,16,18,22,23,25,26,28,30] Korea,[29,32] Japan,[33,34] and Taiwan[17,19] have also increased their research efforts in this area. However, such studies in the People's Republic of China are lacking. To address this gap in the literature, we performed a study in a large cohort of older Chinese veterans to investigate the relationship between PA and depressive symptoms in a nationally representative epidemiological project with adjustment for a comprehensive range of confounders.

Subjects and methods

Study design

A cross-sectional study was conducted from 2009 to 2011 in 277 military communities located in 18 cities nationwide across the People's Republic of China, as a part of the Chinese Veteran Clinical Research project investigating chronic noncommunicable diseases in older Chinese veterans.[35] The study was approved by the ethics committee of the Chinese PLA General Hospital (07BJZ04), and by the ethical review boards in each of the participating districts. All participants signed their written informed consent.

Participants and procedure

Veterans aged ≥60 years who had lived continuously in the community for at least 1 month and agreed to participate in the survey were enrolled. The CVCR protocol is described in detail elsewhere.[35] This paper only describes the methods used to investigate PA and depressive symptoms. A two-stage, stratified, cluster sampling approach was applied. A structured questionnaire was used during a routine, door-to-door census. In the first stage, information on sociodemographics (age, sex, ethnicity, education, marital status, region of residence, living status), lifestyle (PA, hobbies and interests, smoking, alcohol consumption, daily care, participation in social activity), adverse experiences (negative life events, electromagnetic field exposure), and medical conditions (self-rated health, chronic disease, cognitive function) was collected. In the second stage, depression status was evaluated using the Center for Epidemiological Studies Depression Scale (CES-D). There was strict quality control during both stages of the study. The data were obtained directly from subjects if they were cognitively intact or from an informant, who was usually a closely related caregiver, with respect to the subject's condition when the subject was cognitively impaired.

Measurement of depressive symptoms

The level of self-reported depressive symptoms was measured using the Chinese version of the CES-D, which has been evaluated for reliability and validity[36] and extensively utilized in epidemiological surveys in the Chinese population.[37–39] The CES-D is a 20-item self-reported instrument, comprising 16 negative affect and four positive affect items, such as "I felt depressed", "I felt lonely", "I had a poor appetite", and "I was happy". Participants were asked about the number of days on which they experienced every effect item during the previous week. Respondents reported the frequency of occurrence of each negative affect item on a four-point

scale: 0 (rarely or none of the time; less than 1 day), 1 (some of the time; 1–2 days), 2 (much or a moderate amount of the time; 3–4 days), or 3 (most or all of the time; 5–7 days). The four positive affect items were reversed when using the four-point scale. Higher scores on the CES-D indicate more depressive symptoms. A standardized CES-D score of ≤15 is considered normal, a score ≥20 indicates definitive depressive symptoms, and a score >15 and <20 indicates possible depressive symptoms. In our study, cases with depressive symptoms included both definitive and possible ones.

Assessment of physical activity

Questions about participation in leisure activities, including PA and participation in social activities, as well as hobbies and interests, were introduced into the structured questionnaire. Information on PA was self-reported using a one-year PA questionnaire, which was self-administered and convenient to use,[34,40,41] and generally eliminated the influence of season and weather as well as temporary inpatient stays or accident-related events. The focus was on leisure time PA in this study. Subjects or their caregivers were asked to respond to "whether or not the subject regularly participated in any sport or exercise activities in the last one year" with a "yes" if they partook in PA lasting ≥30 minutes a day on ≥3 days a week (active), otherwise as "no" (inactive). Their PA status was dichotomized into active for PA or inactive for PA. The types of PA were also asked and the three dominating types were recorded. The intensity of PA was identified with self-sensations during PA, both of which were accordant. These included a self-detected increase in heart rate, respiration rate, sweating, and muscle fatigue. 60% to 80% of maximal heart rate (220 – actual age), indicates moderate-intensity PA. According to the above, each type of PA was rated as light intensity (self-reported slightly increased heart rate and respiration rate, insignificant sweating, no perceived muscle fatigue, and actual heart rate <60% of maximal heart rate during PA) or moderate-vigorous intensity (marked increase in heart rate and respiration rate, significant sweating, perceived muscle fatigue, and actual heart rate ≥60% of maximal heart rate during PA). If a participant only engaged in light-intensity PA, they were categorized as "light intensity". If a participant engaged in both light and moderate vigorous intensity PA, or only engaged in moderate-vigorous intensity PA, they were categorized as "moderate-vigorous intensity".

Covariates

Subjects were canvassed directly for their sociodemographic data. Hobbies and interests were selected from a list, including calligraphy, painting, photography, collectibles, rearing animals, handcrafts, reading, writing a diary, creative writing, watching television/listening to the radio, and playing cards/mahjong. Smoking was defined as continuous or cumulative smoking of at least one cigarette a day for more than 6 months during life. Drinking alcohol was defined as at least once a week. Daily care requirement and social participation were recorded as "yes" or "no". Negative life events that may affect mental state were elicited, including combat experience, persecution in the Chinese cultural revolution, bereavement, and economic hardship. Occupational electromagnetic field exposure was sought by questioning for a history of working with radar, communications, missiles, or electricity. Self-rated health was evaluated by a standardized multichoice question, "How would you rate your health" on a three-point scale (good, moderate, or poor). Chronic diseases were identified by trained researchers, using a combination of clinical assessment, self-reporting, and medical chart review and were recorded as "yes" or "no". Cognitive function was assessed using a comprehensive test battery, and classified as cognitively normal, mild cognitive impairment, or dementia, according to neuropsychological test scores, such as Mini-Mental State Examination, Montreal Cognitive Assessment, and ability to perform Activity of Daily Living.

Statistical analyses

All data were double-entered and verified in EpiData (version 3.1, The EpiData Association, Odense, Denmark). Descriptive statistics were used to characterize the sample. In univariate analyses (unadjusted model), Pearson's chi-squared test, correction for continuity, or Fisher's Exact probability test were performed as appropriate to calculate the associations for categorical variables, including that between PA and depressive symptoms, to identify underlying correlates. Multivariate logistic regression was used to adjust for any of the factors that reached a P-value ≤0.20 in univariate analyses, to control for possible confounding effects. Sensitivity analyses were performed to examine the influence of missing data. Depressive symptoms were categorized in the above analyses. Once more, the data were analyzed with a continuous CES-D score. A univariate general linear model was used, with CES-D score as the dependent variable, age as the covariate, and the aforementioned categorized factors as independent variables, while adjusting for potential confounders. All statistical analyses were performed using Statistical Package for the Social

Sciences version 18.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was established at a *P*-value of <0.05.

Results

Description of sample

The characteristics of the sample are shown in Table 1. Of 9,676 cases, 8,742 had data available for analysis of depressive symptoms, giving a response rate of 90.35%. The median age was 82.29 (interquartile range 80.25–84.60) years, and ranged from 60 to 105 years. The sample comprised predominantly the oldest old (≥80 years, 70.7%), males (95.7%), people of Han ethnicity (97.9%), the more higher educated (secondary or above education, 60.6%), married and remarried (86.2%), those living in the eastern

Table 1 Characteristics of the study sample

Variables	Cases (%)[a]	Variables	Cases (%)[a]
Age, years	n=8,582	**Self-rated health**	n=8,587
60–69	117 (1.4)	Very good, good	4,739 (55.2)
70–79	2,396 (27.9)	Moderate	3,296 (38.4)
80–89	5,829 (67.9)	Poor, very poor	550 (6.4)
≥90	240 (2.8)	**Negative life event**	n=8,456
Sex	n=8,657	No	7,157 (84.6)
Male	8,288 (95.7)	Yes	1,072 (12.7)
Female	369 (4.3)	Unclear	277 (2.7)
Ethnicity	n=8,642	**Electromagnetic field exposure**	n=8,498
Han	8,458 (97.9)	No	7,726 (90.9)
Minority	184 (2.1)	Yes	566 (6.7)
Education, years	n=8,706	Unclear	206 (2.4)
None	634 (7.3)	**Chronic illnesses**	n=8,634
1–6 (primary)	2,795 (32.1)	Coronary heart disease	5,929 (68.8)
7–12 (secondary)	3,862 (44.4)	Arrhythmia	1,933 (22.6)
>12 (tertiary)	1,415 (16.2)	Hypertension	5,808 (67.3)
Marital status	n=8,612	Hypotension	275 (3.2)
Single	33 (0.4)	Cerebral infarction	1,759 (20.5)
Married	7,166 (83.2)	Cerebral hemorrhage	139 (1.6)
Separated	85 (1.0)	Subdural hematoma	26 (0.3)
Divorced	21 (0.2)	Subarachnoid hemorrhage	27 (0.3)
Widowed	1,023 (11.9)	Transient ischemic attack	679 (7.9)
Remarried	255 (3.0)	Parkinson's disease	254 (3.0)
Other	29 (0.3)	Essential tremor	127 (1.5)
Living region	n=8,742	Brain trauma	228 (2.7)
Eastern	6,183 (70.7)	Brain neoplasm	25 (0.3)
Central	712 (8.2)	Epilepsy	33 (0.4)
Western	1,847 (21.1)	Peripheral neuropathy	145 (1.7)
Living status	n=8,041	Insomnia	1,456 (17.0)
With family/others	7,804 (97.1)	Migraine	378 (4.4)
Alone	237 (3.9)	Dementia	191 (2.2)
Physical activity	n=8,617	Diabetes	2,332 (27.1)
Yes (≥90 min/week)	7,348 (85.3)	Hyperthyroidism	85 (1.0)
No (<90 min/week)	1,269 (14.7)	Hypothyroidism	80 (0.9)
Hobbies and interests	n=8,593	Hyperlipidemia	3,263 (37.9)
Calligraphy	1,759 (20.5)	Hyperuricemia	1,192 (13.9)
Painting	772 (9.0)	Metabolic syndrome	175 (2.0)
Photography	760 (8.9)	COPD	1,113 (13.0)
Collectibles	750 (8.8)	Anemia	310 (3.6)
Rearing animals	1,473 (17.2)	Renal dysfunction	602 (7.0)
Handcrafts	318 (3.7)	Hepatic cirrhosis	94 (1.1)
Reading	7,903 (92.0)	Biliary tract disease	1,561 (18.2)
Writing a diary	1,013 (11.9)	Gastrointestinal tract cancer	320 (3.7)
Creative writing	1,593 (18.6)	Peptic ulcer	813 (9.5)
Watching TV/listening to radio	8,129 (94.7)	Alimentary tract hemorrhage	186 (2.2)
Playing cards/mahjong	2,704 (31.6)	Fracture	746 (8.7)

(*Continued*)

Table 1 (*Continued*)

Variables	Cases (%)[a]	Variables	Cases (%)[a]
Smoking	n=8,546	Muscle disease	27 (0.3)
Current	693 (8.1)	Osteoarthritis	1,900 (22.1)
Quit	2,754 (32.3)	Rheumatic arthritis	419 (4.9)
Never	4,933 (57.7)	Prostatic hyperplasia	6,437 (77.3)
Unclear	166 (1.9)	Prostate cancer	177 (2.1)
Alcohol consumption	n=8,543	Orchidectomy	86 (1.0)
Currently often	611 (7.2)	Cataract	4,849 (56.3)
Quit	1,304 (15.2)	Glaucoma	283 (3.3)
Currently occasionally	1,995 (23.4)	Fundus oculi lesion	1,787 (20.9)
Never	4,494 (52.6)	Hearing disorder	2,180 (25.4)
Unclear	139 (1.6)	**Cognitive function**	n=8,742
Daily care	n=8,535	Normal	4,423 (50.6)
Not required	7,335 (85.9)	Probable MCI	2,664 (30.5)
Required	1,199 (14.0)	Probable dementia	1,630 (18.6)
Social participation	n=8,551	Unclear	25 (0.3)
No	5,166 (60.4)	**Depressive symptoms**	n=8,742
Yes	3,297 (38.6)	No (CES-D ≤15)	8,090 (92.5)
Unclear	88 (1.0)	Yes (CES-D >15)	652 (7.5)

Notes: [a]Values were expressed as number (%). Case numbers did not always total 9,676 due to missing values for some variables.
Abbreviations: COPD, chronic obstructive pulmonary disease; MCI, mild cognitive impairment; CES-D, Center for Epidemiological Studies Depression scale.

part of the People's Republic of China (70.7%), and those living with family/other (97.1%). A greater proportion of the sample participated in PA (85.3%), with hobbies and interests of reading (92.0%) and watching television/listening to radio (94.7%), were never smokers (57.5%), never drinkers (52.6%), did not require assistance with self-care (85.9%), did not actively participate in social activities (60.4%), had good self-rated health (55.2%), and had not experienced negative life events (84.6%) or electromagnetic field exposure (90.9%). The most common chronic diseases were prostatic hyperplasia (77.3%), coronary heart disease (68.8%), hypertension (67.3%), and cataract (56.3%). Almost half the sample (49.1%) had some degree of cognitive decline. The overall prevalence of depressive symptoms in the sample was 6.74% (95% confidence interval 6.24–7.24), which is notably lower than the 40.3% (95% confidence interval 38.7–41.8) reported previously for the general older Chinese population.[39]

Sensitivity analyses were performed to examine the influence of missing data, and Little's missing completely at random test indicated that the missing pattern was random ($P>0.05$) and would be negligible.

Physical activity and depressive symptoms

With regard to leisure time PA, the participants engaged predominantly in light-intensity PA (81.84%), such as walking, biking, dancing, gardening, gate ball, billiards, qigong, and tai chi. A few participants engaged in moderate-vigorous-intensity PA (18.16%), such as running, jogging, swimming, tennis, ping pong ball, and working out at the gym. All leisure forms of PA were noncompetitive.

Many variables were found as to be potentially associated with depressive symptoms in older veterans, and ten were demonstrated to be independently associated with depressive symptoms in adjusted analyses with multivariate logistic regression, as shown in Table 2. With regard to the main focus of this study, in an unadjusted model with univariate analyses, PA (defined as ≥90 minutes a week) was significantly associated with a decreased likelihood of depressive symptoms (5.43% versus 18.83%, $P<0.0001$). After adjusted analyses with multivariate logistic regression for controlling confounders, PA was still inversely associated with depressive symptoms, and was the only independent protective factor identified in this study (OR 0.57, 95% confidence interval 0.44–0.72, $P<0.0001$). The risk of prevalent depressive symptoms among subjects who were physically active (PA ≥90 minutes a week) was decreased by 43% when compared with those who were physically inactive (PA <90 minutes a week). Moreover, there was a significant difference in CES-D scores between the physically active and inactive groups of PA in the univariate general linear model ($F=59.07$, $P<0.0001$), as shown in Table 3.

In contrast, hobbies and interests as calligraphy, painting, photography, collectibles, rearing animals, handcrafts, reading, writing a diary, creative writing, watching television/listening to the radio, and playing cards/mahjong, all categorized as

Table 2 Relationships between physical activity/other variables and depressive symptoms in the study sample

Variables		Unadjusted model		Adjusted model	
		OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Physical activity[a]	(yes versus no)	0.25 (0.21–0.29)	0.000	0.57 (0.44–0.72)	0.000
Age, years[a]	(≥80 versus 60–79)	1.94 (1.58–2.38)	0.000	1.26 (1.03–1.55)	0.027
Sex[a]	(female versus male)	1.88 (1.38–2.57)	0.000	2.31 (1.01–5.35)	0.049
Daily care[a]	(required versus not required)	4.36 (3.71–5.13)	0.000	1.72 (1.36–2.18)	0.000
Self-rated health[a]	(poor versus moderate/good)	5.08 (4.18–6.17)	0.000	1.62 (1.42–1.83)	0.000
Negative life events[a]	(yes versus no)	1.77 (1.44–2.19)	0.000	1.17 (1.04–1.31)	0.008
Parkinson's disease[a]	(yes versus no)	4.56 (3.47–5.99)	0.000	1.53 (1.24–1.88)	0.000
Insomnia[a]	(yes versus no)	2.85 (2.41–3.38)	0.000	4.69 (3.83–5.75)	0.000
Hyperlipidemia[a]	(yes versus no)	1.42 (1.21–1.67)	0.000	1.12 (1.01–1.23)	0.030
Osteoarthritis[a]	(yes versus no)	1.69 (1.42–2.02)	0.000	1.10 (1.09–1.19)	0.014
Calligraphy[b]	(yes versus no)	0.79 (0.64–0.98)	0.031		0.214
Painting[b]	(yes versus no)	1.07 (0.81–1.41)	0.629		–
Photography[b]	(yes versus no)	0.59 (0.41–0.83)	0.002		0.781
Collectibles[b]	(yes versus no)	0.89 (0.66–1.20)	0.451		–
Rearing animals[b]	(yes versus no)	0.76 (0.60–0.96)	0.020		0.243
Handcrafts[b]	(yes versus no)	0.80 (0.50–1.27)	0.342		–
Reading[b]	(yes versus no)	0.46 (0.36–0.58)	0.000		0.336
Writing a diary[b]	(yes versus no)	0.85 (0.65–1.11)	0.241		–
Creative writing[b]	(yes versus no)	0.93 (0.75–1.15)	0.508		–
Watching TV/listening to radio[b]	(yes versus no)	0.53 (0.40–0.71)	0.000		0.144
Playing cards/mahjong[b]	(yes versus no)	0.69 (0.57–0.83)	0.000		0.239

Notes: [a]Ten factors were independently associated with depressive symptoms by adjusted analyses with multivariate logistic regression, with $P<0.05$. Age ≥80, female sex, daily care required, poor self-rated health, negative life events, Parkinson's disease, insomnia, hyperlipidemia, and osteoarthritis were risk factors for depressive symptoms. Physical activity was the only protective factor in this study. [b]The studied hobbies and interests as sedentary behavior were not associated with depressive symptoms in unadjusted or adjusted analyses, with $P>0.05$. Other factors as study variables were not associated with depressive symptoms by unadjusted or adjusted analyses, and are not listed.

Abbreviations: OR, odds ratio; CI, confidence interval.

relatively sedentary behavior, were not associated with a decrease in depressive symptoms in unadjusted or adjusted analyses (see Table 2). There were no significant difference in CES-D scores between groups with these hobbies and interests and those without in the univariate general linear model (see Table 3). Both multivariate logistic regression and the univariate general linear model produced similar results.

Discussion

Key findings

The results of this study confirm and extend previous research by demonstrating an inverse relationship between PA and depressive symptoms in a large cohort of older Chinese veterans. There were also some other important and distinctive findings in this study. Various correlations with depressive symptoms were sought, and PA was found to the only factor protecting against symptoms of depression. Even after controlling for a range of confounders, such as age, sex, variations in lifestyle, negative life events, the most common chronic diseases, and level of cognitive function, the relationship between PA and depressive symptoms remained significant (OR 0.57, 95% confidence interval 0.44–0.72, $P<0.0001$). The independent protective effect of PA on depressive symptoms was far stronger than any of the other healthy lifestyle components, such as the above-mentioned hobbies and interests, social participation, not smoking, and abstaining from alcohol, which were not found to be associated with decreased depressive symptoms. The median (interquartile range) age of the sample was 82.29 (80.25–84.60), making it highly representative of older-old people, and even the oldest-old. There was an indication that the antidepressant effect of PA also extended to the oldest-old, although many researchers thought it difficult to get positive result of PA antidepressant effect in the oldest-old.[4] The majority of study participants engaged in light PA; active PA was defined as ≥90 minutes a week, so PA in this study would have been mainly light intensity. It was shown that light-intensity PA was probably also protective against depressive symptoms, even though the guidelines for PA in older adults mainly recommend PA of at least moderate intensity.

Mechanisms and analyses

The mechanisms that may account for the inverse association between PA and depressive symptoms are not completely understood, but there are several plausible hypotheses. The neurobiological hypothesis suggests that PA may

Table 3 Difference in CES-D scores between (or among) groups of physical activity/other variables in the study sample

Variables	*F*	*P*-value
Physical activity[a]	59.073	0.000
Age[a]	3.851	0.048
Sex	2.829	0.093
Daily care[a]	44.637	0.000
Self-rated health[a]	23.201	0.000
Negative life events[a]	27.051	0.000
Parkinson's disease[a]	27.333	0.000
Insomnia[a]	684.099	0.000
Hyperlipidemia[a]	8.957	0.000
Osteoarthritis[a]	3.996	0.018
Calligraphy[b]	1.309	0.270
Painting[b]	1.009	0.365
Photography[b]	0.999	0.368
Collectibles[b]	1.131	0.323
Rearing animals[b]	2.389	0.092
Handcrafts[b]	0.455	0.635
Reading[b]	1.695	0.184
Writing a diary[b]	0.676	0.509
Creative writing[b]	0.096	0.908
Watching TV/listening to radio[b]	3.847	0.051
Playing cards/mahjong[b]	0.041	0.960

Notes: [a]There were significant differences in CES-D scores between the groups for the nine factors in a univariate general linear model with $P<0.05$. [b]There were no differences in CES-D scores between groups for hobbies and interests in a univariate general linear model, with $P>0.05$.
Abbreviation: CES-D, Center for Epidemiological Studies Depression Scale.

stimulate synthesis, release, and metabolism of serotonin and β-endorphins, increase neurotransmission of norepinephrine, attenuate the response of hypothalamic-pituitary-adrenal axis to reduce levels of cortisol, a stress hormone, stimulate growth of new nerve cells in the hippocampus, and regulate cerebral blood flow, to modify the biochemical and neuroanatomical changes that occur with depression.[42–44] The psychological hypothesis suggests that PA may provide a sense of enjoyment and achievement, provide more opportunities for social interaction, provide a distraction from worries and negative thoughts, enhance self-confidence, self-esteem, and self-determination, and improve self-efficacy.[42,45,46] Further, it should also be considered that PA for older adults yields benefits that extend beyond depression, such as maintenance of functional independence, which might in turn contribute to less likelihood of depression. Factors such as functional independence are generally considered to be a mediator between PA and depression, and could help us to investigate potential mechanisms that may account for the effect of PA on depression. Further studies need to be designed.

A majority of the sample participated in active PA (85.3%), which was encouraging. This may reflect the predominance of men in the sample, who usually do less housework and spend more time outdoors than women. Another important driver of PA in this age group is the social support received from veterans' communities, such as health education, and provision of accessible places and convenient facilities for PA, which spurs people into action.

As demonstrated by previous studies, although the trend of PA is usually downward with advancing age in older adults,[14] PA has been generally considered to have an inverse correlation with depressive symptoms and to be effective in reduce the risk of such symptoms.[15,20] Our study found similarly encouraging evidence. Both with and without adjustment, there was a decreased risk of prevalent depressive symptoms in physically active subjects compared with their physically inactive counterparts. Moreover, of all the factors independently associated with depressive symptoms, we found that PA was the only protective one, even in the oldest-old and when of light intensity. Thus, differences in the ability to engage in PA (eg, very old age, requiring assistance with self-care, multiple comorbidities, and cognitive dysfunction are likely to hamper the ability to perform PA) did not appear to explain the difference in depressive symptoms between physically active elderly and physically inactive elderly. Social support has been demonstrated to be advantageous in improving mental health in the older population, and may be a confounder.[16,47] All our older veterans enjoy Chinese military welfare and are generally provided with optimal health care and social support, including free medicine, regular physical examinations, health management, better social insurance, a good socioeconomic level, good housing, and convenient facilities. There was almost no difference in social support between our physically active and inactive subjects, so the influence of social support on the relationship between PA and depressive symptoms is likely to be negligible. It is suggested that any difference may result from physiological and psychological differences derived from PA, or from other pleasurable pursuits available to physically active subjects. The level of social support was not measured, and some pleasurable activities were not considered, and these need to be studied further.

It is often questioned whether PA has a beneficial effect on depressive symptoms in the oldest-old. A paper by Steffens published in *The Lancet* pointed out that the lack of consistency of results across studies on this topic results at least in part from the difference in mean age between samples.[4] A study sample with a mean age <75 years is more representative of younger old people, and is likely to yield a significant result; however, a study sample with a mean age of >80 years often fails to do so. Our sample had a median age of 82.29 years, so mostly represented the oldest-old.

However, we obtained a surprising result, in that PA was found to protect against depressive symptoms even in the oldest-old. The distinctive condition was inferred to result from the large sample size of the oldest-old (6,069, 70.7%) making relatively weak statistical effect more powerful. The statistical power is superior to that of previous studies.

Most recommendations have reached a consensus that moderate-vigorous-intensity PA has a generally beneficial effect on health.[28,29] In this study, light-intensity PA, such as walking, was more popular among subjects, and was also shown to be achievable for depressive symptoms. The effect of light-intensity PA in older adults was a distinctive finding and has not been fully studied, except for one study conducted by Loprinzi that found light-intensity PA was inversely associated with depressive symptoms in older American adults.[30] Another finding that supervised low-intensity exercise was more effective in reducing depressive symptoms than moderate-intensity or high-intensity exercise in a meta-analysis of outcomes of PA interventions among healthy adults[48] also does not support the common contention that insufficient PA intensity was the reason for poor outcomes.[28] It has been hypothesized that moderate-intensity to vigorous-intensity PA is required for general health (as per the recommendations), whereas light-intensity PA is probably enough for mental health. Further, light-intensity PA may elicit immediate positive feelings that may not be as apparent with more vigorous PA.[3] This deserves more investigation, and if confirmed, promotion of light-intensity PA may be more practical for older adults.

It is stressed that hobbies and interests such as calligraphy, painting, photography, collectibles, rearing animals, handcrafts, reading, writing a diary, creating writing, listening to the radio, and playing cards were not found to have an association with depressive symptoms in this study, although they were thought to be good for maintaining mental health. It is speculated these pastimes are sedentary behaviors, so have poorer physiological effects compared with PA. However, most reflect a healthy lifestyle and should be kept on. Multi-tasking (eg, listening to the radio while walking, performing stretches while watching television, going outdoors for painting or photography, visiting exhibitions of calligraphy or collectibles, going to the library or reading room to read, going to a senior center or community center to play cards) is suggested for the elderly to decrease their sedentary behavior and increase PA at the same time, which should be feasible for older adults.

Strengths and limitations

Here we report the first and largest national epidemiological study in the older Chinese population that explores the relationship between PA and depressive symptoms, and its results are encouraging. The major strengths of this study are its large sample size and high response rate, resulting in good statistical power. Another of its unique characteristics of significantly predominant proportion and absolute number of the oldest-old and the light-intensity PA patterns provided stronger evidence to PA protective effect on depressive symptoms in the two special conditions.

There are also several limitations to this study. First, PA was not measured with a high-quality assessment, so that it may be relatively less reliable. This should be done using either an objective measure (eg, monitor, accelerometer, pedometer) or a more specific questionnaire (eg, the Community Healthy Activities Model Program for Seniors Questionnaire,[49] the International Physical Activity Questionnaire,[50] the Global Physical Activity Questionnaire[51]), all of which result in a quantified level of PA. In this study, PA was categorized as being of light intensity in general, instead of accurate calculation of its energy expenditure. Some other studies have reported the level of PA as estimation of energy expenditure in metabolic equivalents of task,[52,53] or classified it as the low, moderate, or high intensity according to the total PA score shown as continuous variable. This would be worth utilizing in future studies. The second limitation of this study concerns its design; as with other self-reported questionnaire surveys, there is the possibility of recall and reporting bias. Given the cross-sectional nature of our study, causality between PA or other factors and depressive symptoms could not be inferred. Other variables that may be possible confounders need to be further explored in a future study. Because of the widely differing sociodemographic backgrounds between older veterans and the general population of older adults, the generalizability of our study findings to the aged population in general is uncertain.

Conclusion

This nationally epidemiological study demonstrated an inverse relationship between PA and depressive symptoms in a large cohort of older Chinese veterans living in the community. Of all the variables studied, PA was found to be the only independent factor protecting against depressive symptoms, after controlling for a range of confounders. It also indicated that the antidepressant effect of PA probably extended to the oldest-old, and the light-intensity PA was probably available for the same protective effect. Although there are some limitations to this research, the findings are encouraging and could provide useful information for further intervention protocols to prevent or reduce depressive symptoms in older Chinese veterans living

in the community. In particular, it might inspire research concerning the impact of light-intensity PA on depressive symptoms in the oldest-old. The conclusion cannot be extended beyond the study population, but it highlights a direction for further research. PA may be a good way of preventing and treating depressive symptoms and be of great importance in reducing the burden on public health.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Fiske A, Wetherell JL, Gatz M. Depression in older adults. *Annu Rev Clin Psychol*. 2009;5:363–389.
2. World Health Organization. The global burden of disease: 2004 update. Geneva, Switzerland: World Health Organization; 2008. Available from: http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf. Accessed February 21, 2015.
3. Teychenne M, Ball K, Salmon J. Physical activity and likelihood of depression in adults: a review. *Prev Med*. 2008;46:397–411.
4. Steffens DC. Exercise for late-life depression? It depends. *Lancet*. 2013;382:4–5.
5. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep*. 1985;100:128–134.
6. Blake H. Physical activity and exercise in the treatment of depression. *Front Psychiatry*. 2012;3:106.
7. Stavrakakis N, de Jonge P, Ormel J, Oldehinkel AJ. Bidirectional prospective associations between physical activity and depressive symptoms. The TRAILS study. *J Adolesc Health*. 2012;50:503–508.
8. Johnson KE, Taliaferro LA. Relationships between physical activity and depressive symptoms among middle and older adolescents: a review of the research literature. *J Spec Pediatr Nurs*. 2012;16:235–251.
9. Teychenne M, York R. Physical activity, sedentary behavior, and postnatal depressive symptoms: a review. *Am J Prev Med*. 2013;45:217–227.
10. van Uffelen JG, van Gellecum YR, Burton NW, Peeters G, Heesch KC, Brown WJ. Sitting-time, physical activity, and depressive symptoms in mid-aged women. *Am J Prev Med*. 2013;45:276–281.
11. Torres ER, Sampselle CM, Ronis DL, Neighbors HW, Gretebeck KA. Leisure-time physical activity in relation to depressive symptoms in African-Americans: results from the National Survey of American Life. *Prev Med*. 2013;56:410–412.
12. Daniele TM, Bruin VM, Oliveira DS, Pompeu CM, Forti AC. Associations among physical activity, comorbidities, depressive symptoms and health-related quality of life in type 2 diabetes. *Arq Bras Endocrinol Metabol*. 2013;57:44–50.
13. King WC, Kalarchian MA, Steffen KJ, Wolfe BM, Elder KA, Mitchell JE. Association between physical activity and mental health among bariatric surgical candidates. *J Psychosom Res*. 2013;74:161–169.
14. Cohen-Mansfield J, Shmotkin D, Blumstein Z, Shorek A, Eyal N, Hazan H; CALAS Team. The old, old-old, and the oldest old: continuation or distinct categories? An examination of the relationship between age and changes in health, function, and wellbeing. *Int J Aging Hum Dev*. 2013;77:37–57.
15. Salguero A, Martínez-García R, Molinero O, Marquez S. Physical activity, quality of life and symptoms of depression in community-dwelling and institutionalized older adults. *Arch Gerontol Geriatr*. 2011;53:152–157.
16. Litwin H. Physical activity, social network type, and depressive symptoms in late life: an analysis of data from the National Social Life, Health and Aging Project. *Aging Ment Health*. 2012;16:608–616.
17. Chen LJ, Stevinson C, Ku PW, Chang YK, Chu DC. Relationships of leisure-time and non-leisure-time physical activity with depressive symptoms: a population-based study of Taiwanese older adults. *Int J Behav Nutr Phys Act*. 2012;9:28–38.
18. Lucas M, Mekary R, Pan A, et al. Relation between clinical depression risk and physical activity and time spent watching television in older women: a 10-year prospective follow-up study. *Am J Epidemiol*. 2011;174:1017–1027.
19. Ku PW, Fox KR, Chen LJ, Chou P. Physical activity and depressive symptoms in older adults: 11-year follow-up. *Am J Prev Med*. 2012;42:355–362.
20. Walker JG, Mackinnon AJ, Batterham P, et al. Mental health literacy, folic acid and vitamin B12, and physical activity for the prevention of depression in older adults: randomised controlled trial. *Br J Psychiatry*. 2010;197:45–54.
21. Pereira DS, de Queiroz BZ, Miranda AS, et al. Effects of physical exercise on plasma levels of brain-derived neurotrophic factor and depressive symptoms in elderly women – a randomized clinical trial. *Arch Phys Med Rehabil*. 2013;94:1443–1450.
22. Lincoln AK, Shepherd A, Johnson PL, Castaneda-Sceppa C. The impact of resistance exercise training on the mental health of older Puerto Rican adults with type 2 diabetes. *J Gerontol B Psychol Sci Soc Sci*. 2011;66:567–570.
23. Williams CL, Tappen RM. Exercise training for depressed older adults with Alzheimer's disease. *Aging Ment Health*. 2008;12:72–80.
24. Tsang HW, Fung KM, Chan AS, Lee G, Chan F. Effect of a qigong exercise program on elderly with depression. *Int J Geriatr Psychiatry*. 2006;21:890–897.
25. Lavretsky H, Alstein LL, Olmstead RE, et al. Complementary use of tai chi chi augments escitalopram treatment of geriatric depression: a randomized controlled trial. *Am J Geriatr Psychiatry*. 2011;19:839–850.
26. Underwood M, Lamb SE, Eldridge S, et al. Exercise for depression in elderly residents of care homes: a cluster-randomized controlled trial. *Lancet*. 2013;382:41–49.
27. Bridle C, Spanjers K, Patel S, Atherton NM, Lamb SE. Effect of exercise on depression severity in older people: systematic review and meta-analysis of randomised controlled trials. *Br J Psychiatry*. 2012;201:180–185.
28. Nelson ME, Rejeski WJ, Blair SN, et al. Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc*. 2007;39:1435–1445.
29. Cho MH. Are Korean adults meeting the recommendation for physical activity during leisure time? *J Phys Ther Sci*. 2014;26:841–844.
30. Loprinzi PD. Objectively measured light and moderate-to-vigorous physical activity is associated with lower depression levels among older adults. *Aging Ment Health*. 2013;17:801–805.
31. Mammen G, Faulkner G. Physical activity and the prevention of depression: a systematic review of prospective studies. *Am J Prev Med*. 2013;45:649–657.
32. Lee Y, Park K. Does physical activity moderate the association between depressive symptoms and disability in older adults? *Int J Geriatr Psychiatry*. 2008;23:249–256.
33. Tsunoda K, Mitsuishi Y, Tsuji T, et al. [Association of the physical activity of community-dwelling older adults with transportation modes, depression and social networks]. *Nihon Ronen Igakkai Zasshi*. 2011;48:516–523. Japanese.
34. Yoshiuchi K, Nakahara R, Kumano H, et al. Yearlong physical activity and depressive symptoms in older Japanese adults: cross-sectional data from the Nakanojo study. *Am J Geriatr Psychiatry*. 2006;14:621–624.
35. Tan JP, Li N, Gao J, et al. Construction of the Chinese Veteran Clinical Research (CVCR) platform for the assessment of non-communicable diseases. *Chin Med J (Engl)*. 2014;127:448–456.
36. Zhang J, Wu ZY, Fang G, et al. [Development of the Chinese age norms of CES-D in urban area]. *Chin Ment Health J*. 2012;24:139–143. Chinese.

37. Chen J, Zhang LM, Gao L. [Depressive symptom and its influence factor in urban old adults in Wuhan]. *Chin J Gerontol*. 2007;27:275–276. Chinese.
38. Wang SZ, Xia XN. The study of depressive symptoms in elderly veterans in Fuzhou military areas. *Chin J Health Care Med*. 2012;14:28–30.
39. Yu J, Li J, Cuijpers P, Wu S, Wu Z. Prevalence and correlates of depressive symptoms in Chinese older adults: a population-based study. *Int J Geriatr Psychiatry*. 2012;27:305–312.
40. Guallar-Castillón P, Bayán-Bravo A, León-Muñoz LM, et al. The association of major patterns of physical activity, sedentary behavior and sleep with health-related quality of life: a cohort study. *Prev Med*. 2014;67:248–254.
41. Dugan SA, Bromberger JT, Segawa E, Avery E, Sternfeld B. Association between physical activity and depressive symptoms: midlife women in SWAN. *Med Sci Sports Exerc*. 2015;47:335–342.
42. Daley A. Exercise and depression: a review of reviews. *J Clin Psychol Med Settings*. 2008;15:140–147.
43. Dishman RK, O'Connor PJ. Lessons in exercise neurobiology: the case for endorphins. *Ment Health Phys Act*. 2009;2:4–9.
44. Mata J, Thompson RJ, Jaeggi SM, Buschkuehl M, Jonides J, Gotlib IH. Walk on the bright side: physical activity and affect in major depressive disorder. *J Abnorm Psychol*. 2012;121:297–308.
45. Motl RW, Konopack JF, McAuley E, Elavsky S, Jerome GJ, Marquez DX. Depressive symptoms among older adults: long-term reduction after a physical activity intervention. *J Behav Med*. 2005;28:385–394.
46. Ströhle A. Physical activity, exercise, depression and anxiety disorders. *J Neural Transm*. 2009;116:777–784.
47. Lee CT, Yeh CJ, Lee MC, et al. Social support and mobility limitation as modifiable predictors of improvement in depressive symptoms in the elderly: results of a national longitudinal study. *Arch Gerontol Geriatr*. 2012;55:530–538.
48. Conn VS. Depressive symptom outcomes of physical activity interventions: meta-analysis findings. *Ann Behav Med*. 2010;39:128–138.
49. Mesters I, Wahl S, van Keulen HM. Socio-demographic, medical and social-cognitive correlates of physical activity behavior among older adults (45–70 years): a cross-sectional study. *BMC Public Health*. 2014;14:647.
50. Oyeyemi AL, Bello UM, Philemon ST, et al. Examining the reliability and validity of a modified version of the International Physical Activity Questionnaire, long form (IPAQ-LF) in Nigeria: a cross-sectional study. *BMJ Open*. 2014;4:e005820.
51. Misra P, Upadhyay RP, Krishnan A, Sharma N, Kapoor SK. A community based study to test the reliability and validity of physical activity measurement techniques. *Int J Prev Med*. 2014;5:952–959.
52. Laine J, Kuvaja-Köllner V, Pietilä E, Koivuneva M, Valtonen H, Kankaanpää E. Cost-effectiveness of population-level physical activity interventions: a systematic review. *Am J Health Promot*. 2014;29:71–80.
53. Wierniuk A, Włodarek D. Assessment of physical activity, energy expenditure and energy intakes of young men practicing aerobic sports. *Rocz Panstw Zakl Hig*. 2014;65:353–357.